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IS 12465 (1988): Molybdenum wires for lighting and electronic application [MTD 9: Lead, Zinc, Cadmium, Tin, Antimony and their Alloys]

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IS : 12465 - 1988
(Reaffirmed 1999)

Indian Standard

SPECIFICATION FOR MOLYBDENUM WIRES FOR LIGHTING AND ELECTRONIC APPLICATION

UDC 669·28-426 : 621·3·032

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BUREAU OF INDIAN STANDARDS
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1990-07-28

हमारा संदर्भ: पब-SM(12465)/88
विषय: भारतीय मानकों का वितरण

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महोदय,

12465-1988 की छपी अग्रिम प्रति की जांच कराई गई और ठीक पाई गई । हमने इसी क्रम संख्या दिनांक ---------- के पत्र में जो सुधार लिखे थे आशा है वे सभी प्रतियों में कर लिए होंगे । (कृपया शेष 380 प्रतियां हमारे मुख्यालय, नई दिल्ली के वितरण अनुभाग को शीघ्र ही भेजें ।

2. आपके मार्गदर्शन और रिकार्ड के लिए एक प्रमाणित अग्रिम प्रति वापस की जा रही है । कृपया यह सुनिश्चित करें कि पृष्ठों की संख्या और क्रम, शुद्धियों, इत्यादि के संबंध में शेष प्रतियां इस प्रमाणित अग्रिम प्रति के अनुरूप हों ।

भवदीय,

प्रमुख (मुद्रण एवं वितरण विभाग)

संलग्न: उपरिलिखित

प्रतिलिपि प्रेषित:

1. अनु. अधि. (विक्रय) (अगली आवश्यक कार्यवाही के लिए कृपया राशि सप्लाई को अग्रिम प्रतियों के अनुसार जांच करें ।)
2. अनु. अधि. (वितरण)

Indian Standard

SPECIFICATION FOR MOLYBDENUM WIRES FOR LIGHTING AND ELECTRONIC APPLICATION

0. FOREWORD

0.1 This Indian Standard was adopted by the Bureau of Indian Standards on 19 August 1988, after the draft finalized by the Special Alloys Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Molybdenum is one of the naturally occurring element having a cubic body centred crystal lattice. It is a refractory metal having a high melting point of 2 610°C and density of 10·14 g/cm^3, minimum. The material characterized by low thermal expansion, good thermal conductivity and low electrical resistance. Molybdenum wires are produced by hot swaging and drawing the bars obtained by powder metallurgy techniques.

0.3 The object of this standard is to guide the manufacturers and users of electric tubes, semiconductors, incandescent lamps, high temperature furnaces, spray metallizing, etc.

0.4 While preparing this standard, necessary assistance has been derived from the following overseas standards:

ASTM F 289-1981 Molybdenum wires and rods

JIS H 4481-1976 Molybdenum wires for lamps and vacuum tubes

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

---

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard covers the following two grades of molybdenum wire for use in lamps and electron devices:

Grade 1 — Pure molybdenum wire suitable for leads, hooks supports, grids, anchors heating elements and metal-glass seals.

Grade 2 — Pure molybdenum wire suitable for mandrel, either black or cleaned.

2. SUPPLY OF MATERIAL

2.1 The general requirements relating to the supply of this material shall conform to IS : 1387 - 1967*.

3. CHEMICAL COMPOSITION

3.1 Both the grades of wires shall be of 99·90 percent minimum molybdenum, when determined gravimetrically or by a combination of spectrochemical and gravimetrical analysis or by any other standard test method.

4. FINISH

4.1 The molybdenum wires shall be supplied in the following finishes:

a) Finish 1 : Black and drawn;

b) Finish 2 : Cleaned and drawn;

c) Finish 3 : Cleaned and annealed;

d) Finish 4 : Cleaned, annealed and straightened; and

e) Finish 5 : Electro-polished.

5. FREEDOM FROM DEFECTS

5.1 The wires shall be smooth and free from defects, such as fissures, slivers, cracks and burrs.

6. REQUIREMENTS

6.1 Tensile Strength — The tensile strength of the wires shall conform to the requirements as given in Tables 1 to 4, when tested according to **A-1** of Annex A.

6.2 Ductility Test — Knife-edge ductility test is used for wires up to 0·08 mm and mandrel ductility test is used for wires from 0·08 to 0·50 mm inclusive. The wire shall not break or show cracks visible under magnification of 30 × when subjected to ductility test prescribed in **6.2.1** and **6.2.2**.

6.2.1 *Knife-Edge Ductility Test* — For this test, at least 3 metres of wire in the form of spool or band is used. With the spool or band in one hand and a knife in the other, the wire

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*General requirements for the supply of metallurgical materials (*first revision*).

shall be grasped between the thumb and the edge of the knife blade. The knife blade shall be inclined at about 45° to the wire with the back of the blade positioned away from the spool or band. Now pressure shall be applied with the thumb on the wire and knife blade and the latter shall be drawn along the free length of the wire at a rate of about 1 m/s. Pressure shall be applied sufficient to form the wire into a continuous tight helix less than 5 mm outside diameter when the tension is released.

6.2.2 *Mandrel Ductility Test* — For this test, the mandrel diameter shall be 1½ times the diameter of the wire to be tested. One end of the mandrel shall be clamped in a bench vise. One end of a 250 mm wire specimen shall be wrapped tightly 360° around the mandrel in a plane perpendicular to the mandrel. The wire shall be unwound in approximately the same plane and pulled to substantial straightness.

6.3 Straightness — The wires less than 0·12 mm in diameter shall have a natural hanging length of 800 mm for a wire length of 1 000 mm. The wires more than 0·12 mm in diameter, when cut to a length of 200 mm, shall have a maximum height of less than 10 mm for a chord length of 100 mm. Higher diameter wires shall be cut to the specified length and placed on a smooth surface and height corresponding to the length of the chord shall be measured, and shall be as agreed to between the purchaser and the manufacturer.

6.4 Heating Brittleness — The wires shall show no defect, such as breaking, cracks, burs, etc, when subjected to heating brittleness test in accordance with **A-2** of Appendix A.

7. DIMENSIONS, MASS AND TOLERANCES

7.1 Tolerances on Diameter — The tolerances on the diameter of wire shall conform to Table 5.

7.2 The out-of-roundness of the wire having diameter between 0·13 and 0·50 mm shall be within 4 percent of the average diameter.

7.3 Length — The length of a piece of wire shall conform to Table 6.

TABLE 1 TENSILE PROPERTIES FOR FINISHES 1 AND 2

(*Clause* 6.1)

Wire Size mg/200 mm	Maximum Diameter mm	Tensile Strength, *Min*, g/mg/200 mm	Elongation in 250 mm, Percent	
			Grade 1	Grade 2
Up to 4·00	0·050	50	> 6	≤ 6
Over 4·00 to 6·75	0·065	46	> 6	≤ 6
Over 6·75 to 10·20	0·080	44	> 6	≤ 6
Over 10·20 to 398·2	0·500	40	> 6	≤ 6

a) Tensile strength in MPa = 37·65 × tensile strength in g/mg/200 mm

b) Wire diameter (mm) = 0·001 × $\sqrt{\text{mass in mg/200 mm} \times 627{\cdot}8}$

TABLE 2 TENSILE PROPERTIES FOR FINISH 3

(*Clause* 6.1)

Wire Size mg/200 mm	Maximum Diameter mm	Tensile Strength, *Min*, g/mg/200 mm	Elongation in 200 mm, Percent	
			Grade 1	Grade 2
Over 6·75 to 10·20	0·080	40	—	—
Over 10·20 to 398·2	0·500	35	—	—

TABLE 3 TENSILE PROPERTIES FOR FINISH 4

(*Clause* 6.1)

Wire Size mg/200 mm	Maximum Diameter mm	Tensile Strength, *Min*, g/mg/200 mm	Elongation in 200 mm, Percent	
			Grade 1	Grade 2
Up to 4·00	0·050	23	> 12	≤ 12
Over 4·00 to 6·75	0·065	22	> 15	≤ 15
Over 6·75 to 10·20	0·080	20	> 15	≤ 15
Over 10·20 to 398·2	0·500	19	> 15	≤ 15

TABLE 4 TENSILE PROPERTIES FOR FINISH 5

(*Clause* 6.1)

Wire Size mg/200 mm	Maximum Diameter mm	Tensile, Strength, *Min*, g/mg/200 mm	Elongation in 200 mm, Percent	
			Grade 1	Grade 2
Over 6·75 to 10·20	0·080	55	> 5	≤ 5
Over 10·20 to 398·2	0·500	50	> 5	≤ 5

TABLE 5 TOLERANCES ON DIAMETER

(*Clause* 7.1)

Grade	Diameter mm	Tolerance Percent	Mass mg/200 mm	Tolerance Percent
Grade 1	All Sizes	± 2·5	All sizes	± 5
Grade 2	Up to 0·50	± 1	⩽ 400	± 2
	Above 0·50	± 1·5	> 400	± 3

TABLE 6 LENGTH

(*Clause* 7.3)

Thickness/Diameter µm	Length m
Less than 100	300, *Min*
100 to 400 excluding	100, *Min*
400, *Min*	Length corresponding to 130 g, *Min*

8. COILING AND SPOOLING

8.1 The spools or bands shall be clean and free of seams or projections that might catch or tangle the wire during unwinding. The wire shall be in one continuous length and wound smoothly in layers, with no piling upon turns, so that it unwinds freely without forming kinks. Inner and outer ends shall be firmly attached to the spool or band by suitable means. The spool shall be shipped in a container that will prevent contamination of the wire. No spools or bands shall be filled higher than 1·5 mm from the top of the flange. The size of spool, band or coil shall be as agreed to between the purchaser and the supplier.

9. BASIS OF PURCHASE

9.1 Order for molybdenum wire covered by this specification shall include the following information:

a) Grade,

b) Length of wires,

c) Finish,

d) Mass or size and tolerance, and

e) Specification number.

10. PACKING AND MARKING

10.1 Spools and bands containing molybdenum wires shall be packed in suitable containers to avoid damage during transit and storage. Small bags of silica gel shall be placed inside the container for moisture absorption. Each spool shall be marked with the name of the manufacturer, mass in mg/200 mm or the diameter in mm or both, manufacturer's type number, spool number, date of manufactutre and length in metres.

10.2 The material may also be marked with the Standard Mark. Details available with the Bureau of Indian Standards.

ANNEX A

(*Clauses* 6.1 *and* 6.4)

TEST METHODS

A-1. TENSILE STRENGTH

A-1.1 Apparatus — Any standard testing machine that applies the load at a constant rate of traverse or a machine calibrated in terms of a constant rate of traverse shall be satisfactory. The capacity of the testing machine shall be such that all specimens fail at greater than 40 percent of the capacity of the machine. The clamps used shall be such that there will be no slipping of or damage to the test specimen.

A-1.2 Procedure — Determine the tensile strength on a specimen of 200 mm length at room temperature. The initial load applied to the specimen before making the test shall be sufficient to keep the wire straight. The rate of traverse shall be 25 mm/min. If the specimen breaks within 12·5 mm of the clamps, the test shall be repeated.

The report shall include the average of at least three determinations each of the tensile strength and expressed in g/mg/200 mm or in MPa.

A-2. HEATING BRITTLENESS

A-2.1 The wire shall show no defect, such as breaking, fissures, cracks burrs, etc, when subject to the test given in **A-2.2**.

A-2.2 A hydrogen furnace of 25 to 50 mm inside diameter and having uniform heating zone of 200 mm or more in length shall be maintained at a furnace wall temperature of approximately $1\,550 \left(\begin{smallmatrix}-0\\+20\end{smallmatrix}\right)^{\circ}$C. The test piece of wire shall be placed in a ceramic boat and charged into the furnace. After being heated for one minute at $1\,550 \left(\begin{smallmatrix}-0\\+20\end{smallmatrix}\right)^{\circ}$C, the wires should be able to stand a bending of 90° over 10 mm diameter rod.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.